



CAD & GIS Interoperability

**Mark E. Violette, PLS
Schofield Brothers of New England, Inc.
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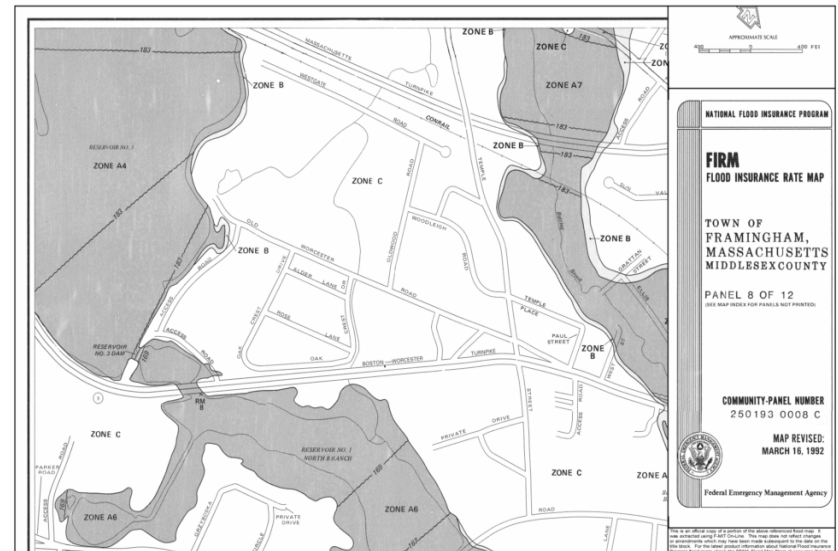
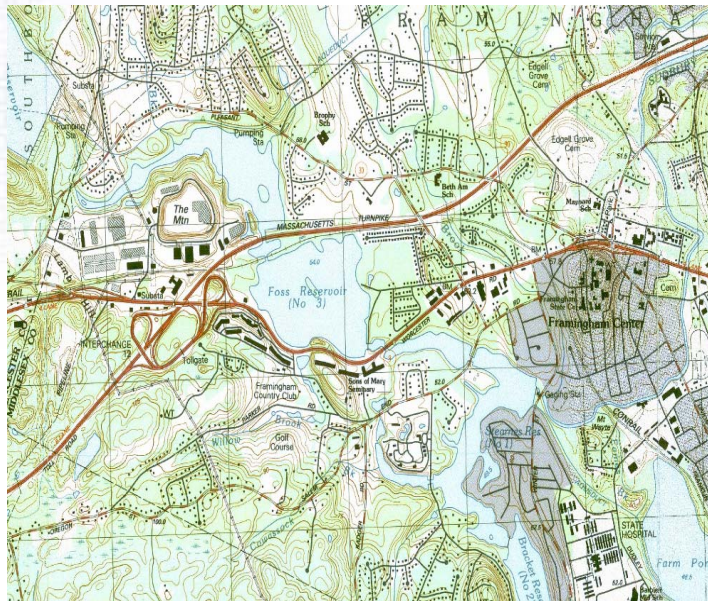


Utilizing GIS data in AutoCAD Map

The following presentation will review accuracy standards and describe some of the methods we use to import GIS data into AutoCAD Map and then show some comparisons to survey data.

Introduction

- Most of our projects begin by collecting available GIS data primarily for estimation, evaluation, consultation, planning and querying purposes. We utilize data obtained from MassGIS and various towns.
- Previously we would need to use multiple paper maps of various sources and either look at them side by side or use scaling and digitization to overlay the data. This data is readily available electronically and has been georeferenced to a common coordinate system.





Layer Accuracy & Limitations

Most of the layers are for planning purposes only and has been developed at a variety of scales . It is important to understand the level of accuracy and use limitations associated with each layer. Knowing and understanding the original map scales and methods used to develop GIS data is critical.

For certain regulatory, legality and design purposes, many of the layer boundaries require specific procedures to determine their locations, some of which are regulated by applicable state laws such as boundary law and delineation of wetland lines. Most of this information (metadata) is referenced for each layer on the MassGIS Layer Info page.



National Map Accuracy Standards

National Map Accuracy Standards establish accuracies required for horizontal and vertical positioning for most map making and are as follows:

Horizontal: For maps larger than 1:20,000 not more than 10% of the data can be more than $\frac{1}{30}$ of an inch of the map scale and for maps smaller than 1:20,000 it is $\frac{1}{50}$ of an inch of the map scale.

In other words, a 1:20,000 scale map is equivalent to $1'' = 1,666.66' \div 30 = 55.55'$. Therefore, 90% of the well-defined features shown must be within 55.55' from their true location.

Vertical: No more than 10% of the interpolated elevations shall be in error of $\frac{1}{2}$ the contour interval.

In other words, if 2' contours are shown, then 90% of those contours need to be within 1 foot of the actual elevation.



National Map Accuracy Standards

- **Following are horizontal tolerances for typical mapping scales.**
- **1:100,000 equivalent to 1" = 8,333' - 90% within 167'**
- **1:25,000 equivalent to 1" = 2,083' - 90% within 42'**
- **1:12,000 equivalent to 1" = 1,000' - 90% within 33'**
- **1:5,000 equivalent to 1" = 417' - 90% within 14'**
- **Following are horizontal tolerances for typical plan scales.**
- **1" = 100' 90% within 3.33'**
- **1" = 50' 90% within 1.66'**
- **1" = 40' 90% within 1.33'**
- **1" = 30' 90% within 1.00'**
- **1" = 20' 90% within 0.66'**
- **1" = 10' 90% within 0.33'**



Typical Layers

Typical layers we use

Orthoimagery

Wetlands

Contours

Soils

Buildings

Town Lines

Assessors Parcels

Natural Heritage

Zone II's

Title V setback lines

Zoning

Utilities



Orthoimagery

In order to better utilize GIS layers, most of our projects start by using orthoimagery either from MassGIS or town data we have obtained.

Orthoimagery rectifies aerial photography. This process removes most of the distortion and scale variations caused by terrain relief and sensor movement and “flattens” out the surface of the earth for mapping purposes.

To create a digital orthophoto, several key input files are necessary: aerotriangulation (horizontal and vertical ground control), aerial photos with a high-percentage of overlap, scanned imagery, and a digital elevation model (DEM).

The DEM typically models the earth's surface only, which results with distortions of the objects that protrude from the earth's surface. (Bridges, buildings, etc.)

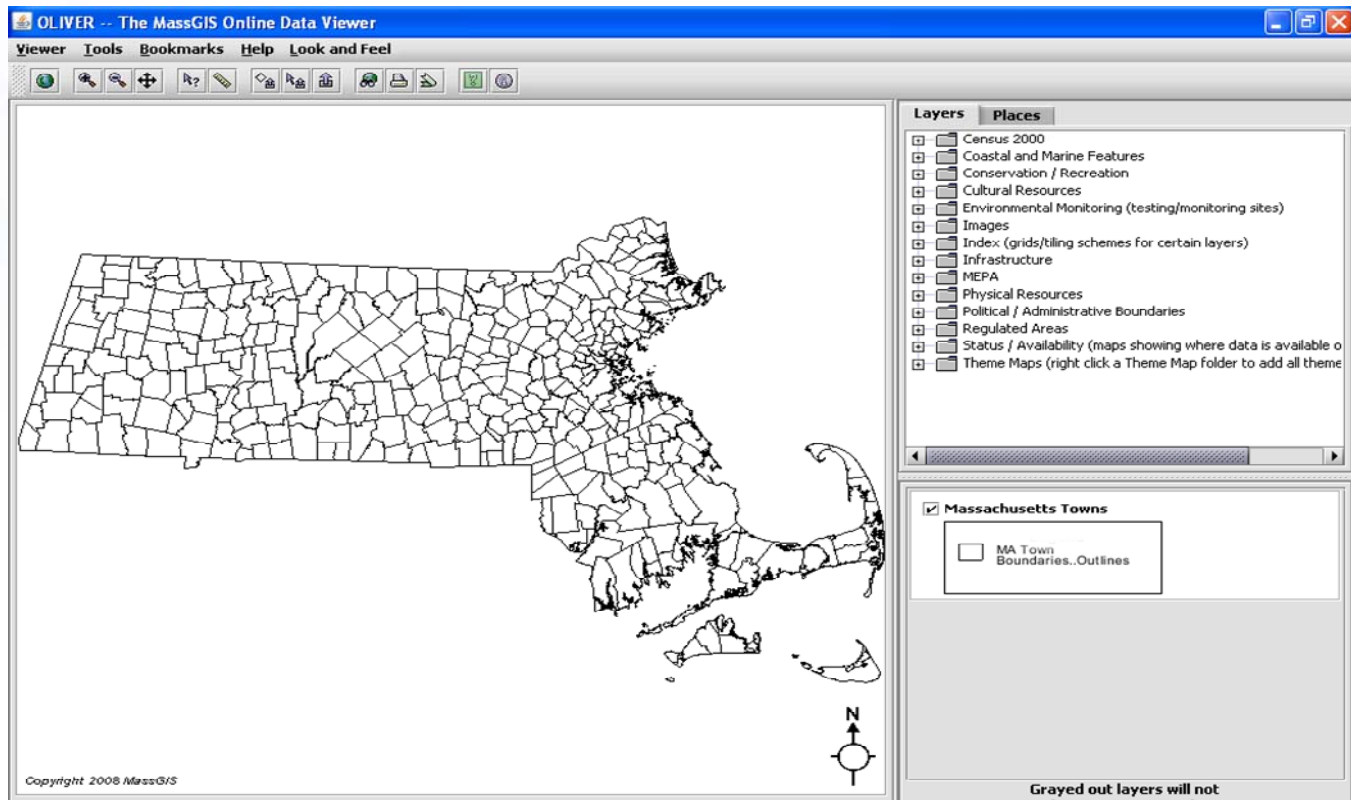


Orthoimagery

- **The layer info page for the MassGIS orthos states that the “image horizontal accuracy is +/-3 meters at the 95% confidence level at the nominal scale of 1:5,000”**
- **That’s about 9.8’, which is within the 14’ required by the National Map Accuracy Standards for that scale.**
- **The layer info page also states that the images are 1/2-meter pixel resolution resulting with an approximate 1.6’ “fuzz” factor with the image.**
- **From our experience with MassGIS orthos, we have found that well-defined features, (not elevated off the surface of the earth) such as edge of pavement, walks and concrete pads, to be well within the 9.8’ tolerance.**

GIS Data Acquisition

We currently obtain a majority of MassGIS data using Oliver and its extraction tools. This minimizes our need to maintain data layers on our server, provides access to the most current/available information and quick access to the Layer Info page. We also have obtained varying amounts of data for approximately 36 towns and orthos for 10 towns.





GIS Data Acquisition

- **Taking note of the coordinate system and units, the appropriate ortho image is imported into AutoCAD Map.**
- **Selected data is exported out of Oliver or ArcMap as a shape file and imported into AutoCAD Map.**
- **Most of our work is done in feet, so if necessary convert data to Massachusetts State Plane NAD 1983 and US Survey Foot.**
- **The MassGIS data is in metric units and is scaled by 3.280833333333 (US Survey Foot). Due to AutoCad's unit conversion being the International Foot, this exact scale factor must be used or the data will be misplaced by approximately 20 to 60 feet depending where you are in the state.**



Adding Survey Data

We generally use two methods to add survey data.

- Method 1

- Collect the data on the same coordinate system either from previously established control or establish points using GPS devices. Be aware that not all GPS devices provide the same level of accuracy.
- Survey grade GPS devices provide subcentimeter accuracy through either post-processing or real time corrections.
- Handheld GPS devices, without post-processing, can provide accuracies from approximately 9' to 50'. Devices with post-processing approximately 3'
- Verify consistency of units. (decimal degrees, degrees & minutes, degrees, minutes & seconds).



\$200



\$2,000



\$25,000



Adding Survey Data

- Method 2

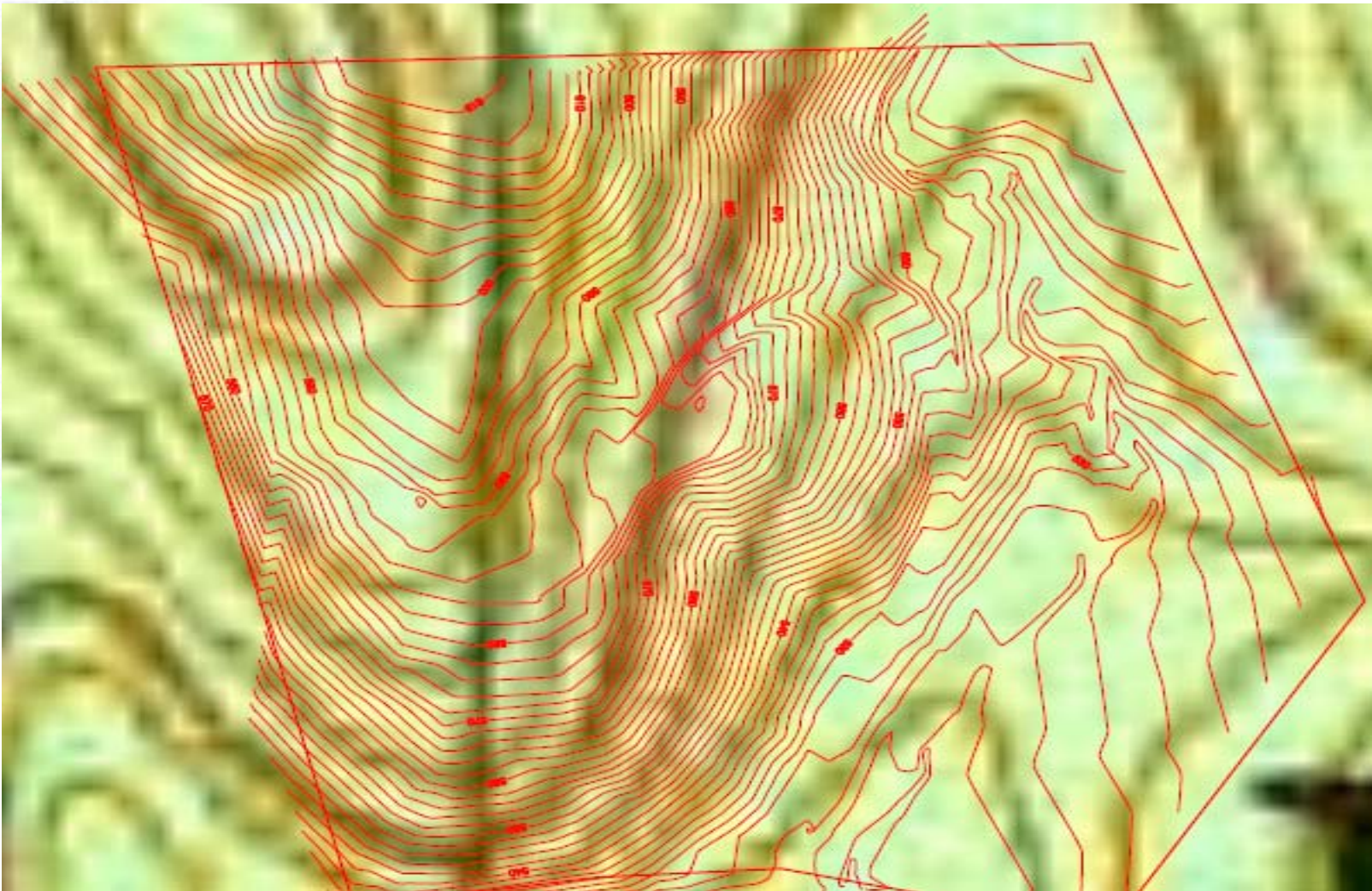
- Is to approximately orient survey data to the ortho by a “best fit” using survey plans and/or field locations of well defined features such as edge of pavement, walks and concrete pads.

- This method is primarily used to minimize the costs associated with using GPS.

- Plans and deeds are added using coordinate geometry and oriented to the ortho. Attention is made to the plans north origin. If plans are already on True North or State Plane, they are only placed on the ortho and not rotated.

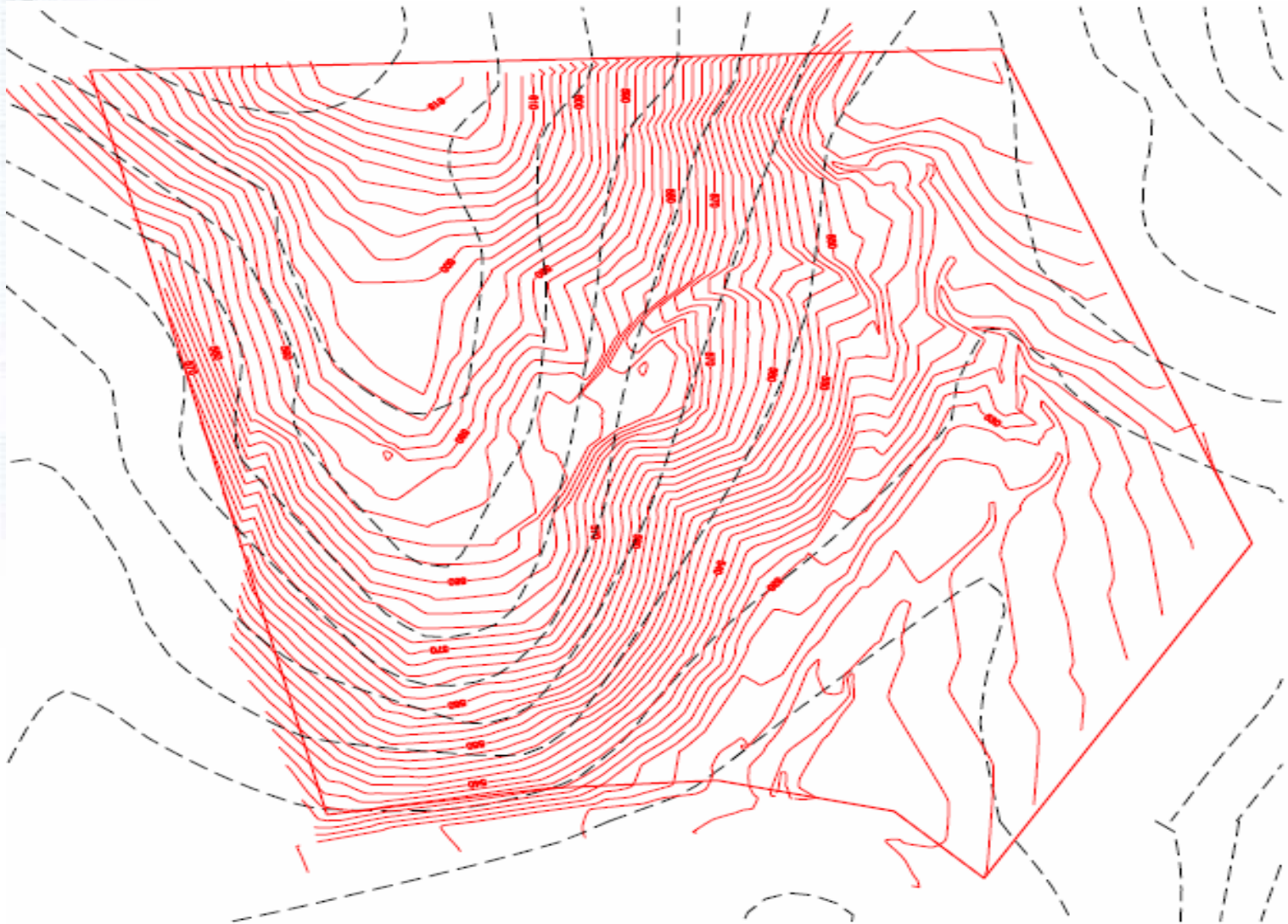
Data Comparisons

- **Contours - Survey to Quad**



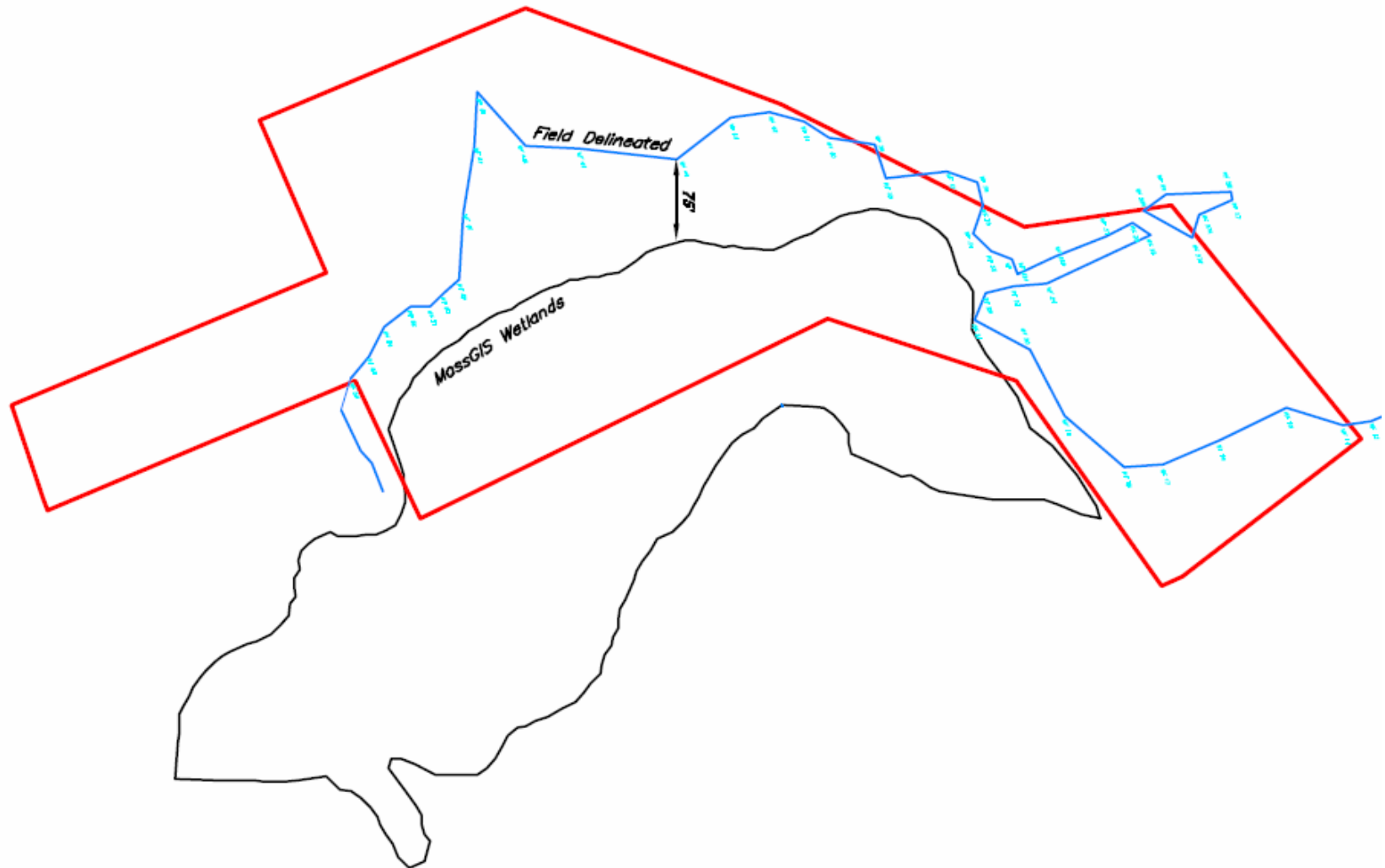
Data Comparisons

- **Contours - Survey to GIS**
- Survey = Red
- MassGIS = Black



Data Comparisons

- **Wetlands - Survey to GIS**



Data Comparisons

- **Buildings - Survey to GIS**
- Survey = Yellow
- Town of Natick = Cyan

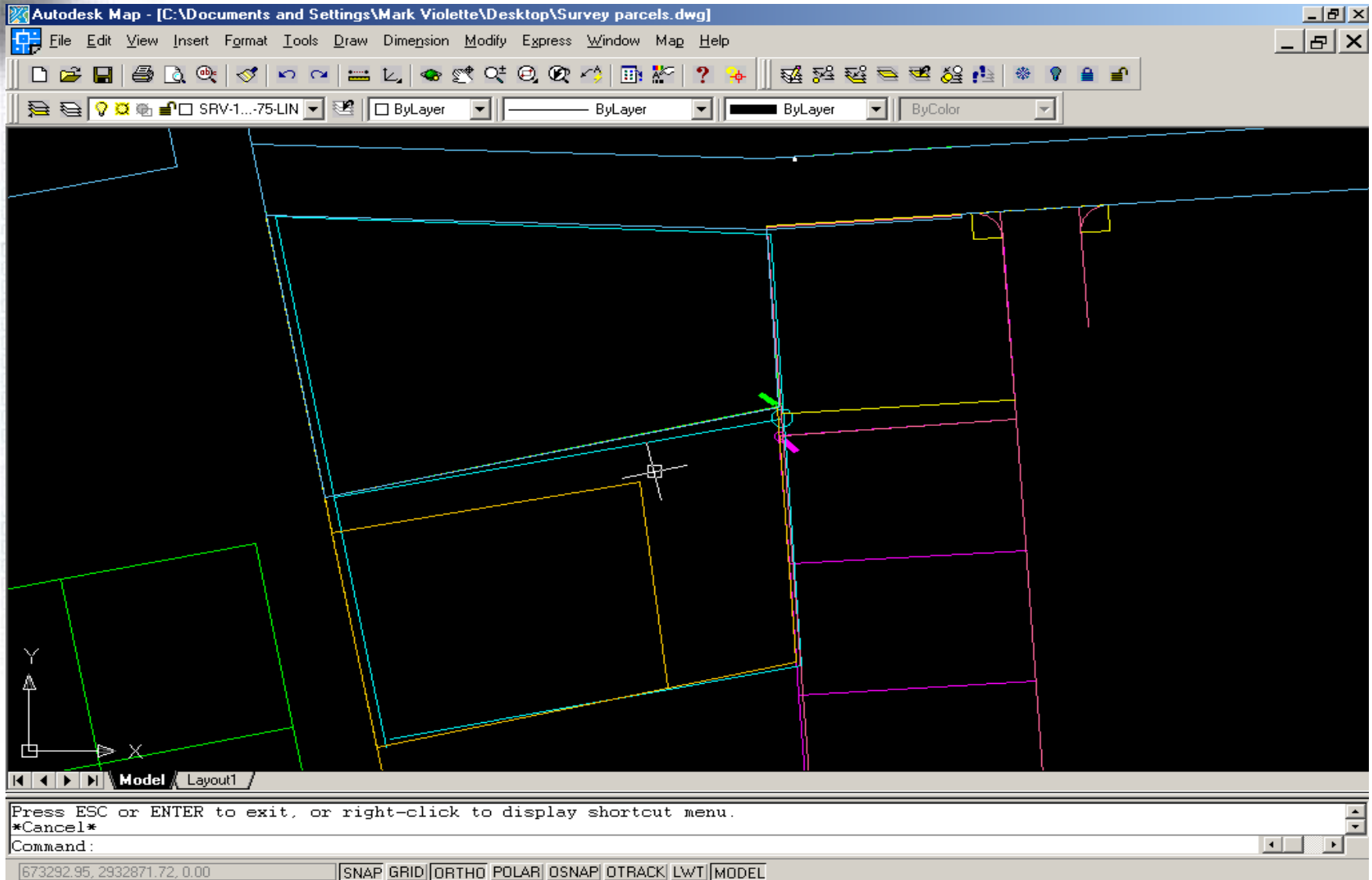




Parcel Mapping

- Most of the parcel mapping is derived from Assessors Maps, which were developed for assessment purposes only. There were no accuracy standards required for their development.
- We have used these maps for a number of years for general reference to research properties, but their depiction of property lines holds very little weight due to their inaccuracies.
- Many of the inaccuracies are due to poorly written deeds (no angles or distances), insufficient survey data, incorrect survey data and conflicting survey data.

Parcel Mapping





Parcel Mapping

Some towns have more survey data available and have invested more money into their parcel mapping and provide a closer representation of the true parcel configurations.

The parcel mapping with attribute data has enabled us to save a significant amount of research time, limiting the need to go to town offices and allowing us to generate reports without having to hand write everything.

MassGIS has developed Standards for Digital Plan Submittals and Digital Parcels which should help improve this layer significantly.



Conclusion

The availability of this data has been extremely useful for our business. Although we ultimately need to locate many of the features more accurately, having the ability to quickly compile large amounts of preliminary data is a tremendous help in estimating, planning and preparing for potential permitting requirements.

One drawback of having this data easily available for use by the general public, is that it enables un-trained individuals to use the data. People tend to believe that maps are more accurate than they are, especially when they look good.

MassGIS has done an excellent job providing disclaimers and metadata for each of the layers it provides, but too often individuals either don't read or don't understand the information.

Using these layers beyond their intended use could cause harm to the public and all users should use the data responsibly, especially using the distance tool

